



Newsletter

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The Hudson River is an ecosystem constantly in the news. Questions and controversies about the Hudson often have an ecological dimension. For example, many of the concerns about toxic materials focus on the transfer of chemicals through food chains to humans. Given the significance of environmental questions regarding the Hudson, it is important to ask how well we know how the river works as an ecological system.

A team of IES scientists has focused on this problem since 1986. The group has made remarkable progress and their research has contributed fundamental new knowledge about the Hudson River in particular as well as rivers and estuaries in general. Recently completed studies on the effects of the zebra mussel invasion into the river have led to a new series of questions about the role of aquatic vegetation that grows in the shallows and how these plants affect ecological interactions. The IES team is pushing forward on this topic and some early findings are highlighted in this issue.

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Director: Gene E. Likens
Administrator: Joseph S. Warner
Head of Education: Alan R. Berkowitz
Newsletter editor: Jill Cadwallader

Address newsletter correspondence to the editor at:

Institute of Ecosystem Studies
Education Program, Box R
Millbrook NY 12545-0178
e-mail: Cadwalladerj@ecostudies.org

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Zebra Mussels, Oxygen and the Hudson River Ecosystem: IES Scientists Work in the Weeds

To turn a chunky soup into clear broth, you strain it through the culinary equivalent of a filter. To turn a murky river or lake into one that's less murky ... should you bring on the filter-feeders??

No, clearly not — as you will see, the effects of that could be larger than anything you would want to face. IES scientists doing research on the Hudson River are discovering an increasingly complex array of changes in the river's ecosystem that appear to be directly related to the feeding habits of zebra mussels.

By now, less than a decade after zebra mussels extended their range to the Hudson River, the "invasion" itself is old news. In 1985, the animals were stowaways on a European cargo ship that discharged its ballast water into Lake St. Clair in the Great Lakes. Adaptable, opportunistic and prolific, they spread rapidly and were identified in the Hudson River near Catskill in May 1991; Institute of Ecosystem Studies ecologists found the first ones at Poughkeepsie three months later. By September 1992, the total weight of zebra mussels in the Hudson River was greater than the total weight of all other river animals combined.

Mussels — together with their fellow bivalves, scallops, oysters and clams — are filter feeders. To eat, they draw water through partly spread shells, over gills that trap tiny particles. Beating cilia on the gills move the particles toward the animal's mouth. Floating particles in rivers are a "soup" of phytoplankton, zooplankton, bacteria, detritus and silt; zebra mussels filter out phytoplankton and silt with nearly equal efficiency. The rate of filtration, says Dr. David Strayer, an Institute aquatic ecologist, is a good measure of impact on the ecosystem, and the Hudson River's zebra mussels filter the entire freshwater estuary in from just 1 to 4 days. The water has been so well filtered, it turns out, that light penetration during the summer months has increased by almost 50%. "Few other human-caused events in the history of the river," write Dr. Strayer and IES colleagues¹, "have had such

large, wide-spread and potentially long-lasting effects on the Hudson ecosystem."

The survival of fish and other aquatic organisms is dependent upon an adequate level of dissolved oxygen in their underwater environment. Dr. Nina Caraco is the principal author of a paper² that describes a decline in dissolved oxygen (DO) in the Hudson River. Considering all factors that could cause this decline, she and her colleagues conclude that it is due to the



LONNA KELLY

Dr. Caraco with an automatic sensor called a sonde. From April through October, at sampling sites in the Hudson River from Albany south to Newburgh, she and her colleagues deploy these underwater instruments. Sondes collect data continuously, on oxygen, temperature, pH, turbidity and depth. Periodically the scientists return to the sites, pick up the sondes and put out replacements. Back in the laboratory, the instruments are attached directly to a computer and data are downloaded.

presence of zebra mussels. As part of their Hudson River monitoring program, IES ecologists have been measuring DO for over a decade, and, by comparing their data to the timing and range of zebra mussel establishment, they found that levels declined significantly as the animals spread. This decline is due to the substantial respiration of the huge zebra mussel population. But, realizing that that the drop in DO should have been twice what they had observed, the scientists investigated further and discovered a compensatory effect within the ecosystem. "Submersed macrophytes," says Dr. Caraco, "have made up the difference."

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1. "Transformation of Freshwater Ecosystems by Bivalves: A case study of zebra mussels in the Hudson River", by D.L. Strayer, N.F. Caraco, J.J. Cole, S.E.G. Findlay and M.L. Pace. *BioScience*, January 1999.

2. "Dissolved Oxygen Declines in the Hudson River Associated with the Invasion of the Zebra Mussel (*Dreissena polymorpha*)", by N.F. Caraco, J.J. Cole, S.E.G. Findlay, D.T. Fischer, G.G. Lampman, M.L. Pace and D.L. Strayer. *Environmental Science and Technology*, in press.

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A New Focus: Water Celery and Water Chestnut

Growing in shallow areas of the Hudson River are two types of large rooted plants, collectively called macrophytes: the native water celery, *Vallisneria americana*, and the non-native water chestnut, *Trapa natans* (those of you familiar with the river will have seen the large, spiny seeds produced by the latter). Thanks to filter-feeding zebra mussels and the resulting increase in light penetration, production of oxygen by macrophytes has increased to the point where it partially compensates for the zebra mussels' tremendous respiratory demands.

Dr. Stuart Findlay has been studying the submersed vegetation in the Hudson River since 1993, and has used aerial photography to map rooted plants in the river from Hyde Park north to Albany. Beds of water celery and water chestnut show up clearly, the former dark and the latter a bright green, and Dr. Findlay has been able to determine what percentage of the river has macrophyte growth. It is clear, he says, that these plants are more important than they used to be, since phytoplankton populations are down and light penetration is up ... both a result of zebra mussel feeding behavior. But what do they mean to the Hudson River ecosystem? Institute of Ecosystem Studies aquatic ecologists are broadening the scope of their river research to answer that question.

This new IES Submersed Aquatic Vegetation Study, which also involves a number

Left: The top portion of a Vallisneria americana (water celery) leaf, actual size. Illustration by Linda Beckwith McCloskey, from: Hudson River Field Guide to Plants of Fresh-water Tidal Wetlands

of outside collaborators³, has three parts, Dr. Findlay explains. First, there was the original mapping to learn the extent of water celery and water chestnut beds. Next is what he calls a functional assessment, a thorough examination of the water, sediments, plants and animals associated with the macrophytes — much of this phase of the work will be done this summer. Finally, the Institute will continue to do regular monitoring to assess changes that accompany the inevitable alterations in size and character of macrophyte beds.

Dr. Jonathan Cole and Dr. Caraco will be focusing on oxygen dynamics. Dr. Cole describes a significant difference between the two macrophytes: while water celery lives predominantly under water, and therefore releases the oxygen it produces to the water column, mature water chestnut floats at the surface unless the tide is particularly high. Therefore, the floating rosettes of water chestnut release their oxygen to the air, instead of contributing to dissolved oxygen in the river water. The prediction: water in *Vallisneria* beds has abundant oxygen while water within *Trapa* beds frequently has very little. Drs. Cole and Caraco will be trying to determine if this is actually the case, how oxygen levels are affected by incoming and outgoing tidal flow, and what role is played by the sediments trapped in the beds.

Dr. Michael Pace is studying the smallest creatures in the beds, the bacteria and zooplankton that form the base of the river's food web. As macrophytes die and decay, do they become a significant food source for these very important microscopic organisms? Sampling along transects across beds and bare river bottom, Dr. Pace will be collecting data at sites from Albany south to the Tappan Zee Bridge in Tarrytown.

Moving up the size scale, Dr. Strayer's focus in the study is the hundreds of species of

algae that are attached to the leaves of the macrophytes, and the rich and diverse collection of invertebrates — midges, caddisflies, mayflies, beetles, amphipods, snails and more — that complement the community. His work initially will be descriptive, to document the types and numbers of these plants and animals, and to determine if there is enough algae growing within the plant beds to be a significant food source for river animals of all sizes.

Now that the mapping is completed, collaborating scientists will be studying fish and their relationship with water celery and water chestnut. It is assumed that fish — especially little ones — seek shelter in the dense beds. But what happens beneath the water chestnut canopy when dissolved oxygen levels approach zero? Local bass fishermen anchor their boats by these beds, having learned that the best catches come at the outgoing tide. Is this because fish are abandoning their oxygen-depleted hideouts? (It is important to note, here, that the incoming tide brings oxygen, which can be respired away by the time the tide turns.) The IES research team will be developing ways to measure scientifically the comings and goings of fish and other organisms.

"Most aquatic ecologists don't start their research in weed beds because they're a mess," says Dr. Strayer. "Weeds are patchy, things grow on plants and between plants, habitats are complicated." But, he continues, this group of IES scientists has been drawn to

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Dr. Pace investigates interactions between bacteria and zooplankton and the Hudson River's water celery and water chestnut beds.

LONNA KELLY

IES Staff Notes

Institute of Ecosystem Studies adjunct scientist **Dr. Juan J. Armesto**, a forest ecologist and professor at the Universidad de Chile in Santiago, is a recipient of a "Presidential Chair in Sciences" award. Dr. Armesto does his field work on the Chilean island of Chiloe, where the endowed three-year chair will enable him to study two processes of forest change, the transport functions that connect species — primarily pollination and seed dispersal by birds — and the structural function of old trees, snags and fallen logs.

An international panel of scientists reviews candidates for the Presidential Chair, and in 1999 made twelve awards to outstanding Chilean scientists in all fields of the basic sciences. Dr. Armesto noted that, since Chile has an exceptionally clear atmosphere, the fields of astronomy and astrophysics are usually among the strongest contenders for these awards, while awards supporting ecological research are still uncommon — only four out of more than 40 in the last three years have gone to ecologists.

Dr. Armesto has been collaborating with IES scientists since the mid-1980s, when he was a Ph.D. student at Rutgers University doing research with Drs. Steward Pickett and Mark McDonnell* on the process of woody species invasion into abandoned agricultural fields. In recognition of his ongoing collaborations, as well as of his contributions to ecological research, he was appointed adjunct associate scientist at the Institute in 1990 and adjunct scientist in 1998. (* Dr. Pickett is a plant ecologist at IES, and principal investigator on the Baltimore Ecosystem Study. Dr. McDonnell, an IES ecologist from 1984-1993, was recently appointed Director of the Australian Research Centre for Urban Ecology.) ●

Dr. Doris Soto has joined the IES scientific staff as an adjunct scientist. Dr. Soto, who since 1990 has been collaborating with Institute Director Dr. Gene Likens on research about lakes and streams of southern Chile, is an aquatic ecologist and full professor at the Universidad Austral de Chile in Puerto Montt (a city roughly halfway between Chile's capital of Santiago and the southern tip of the country). "Sharing ideas in science is one of the most interesting issues to me," Dr. Soto says, "and [this adjunct position] will help me find more productive links with other people's ideas." To this end, Dr. Soto will be continuing her work with Dr. Likens and also will be collaborating with other IES scientists. She and Dr. Michael Pace, for example, plan to

work together on a study of zooplankton, dissolved organic carbon and nutrients in Chilean lakes, and her work with freshwater mussels in Chile ties her closely to the research of Dr. David Strayer. Dr. Soto will visit IES two or three times each year, and IES ecologists will travel to Chile to pursue collaborative investigations there. ●



Institute scientists undergo periodic review by peers at other institutions. As a result of a review done in 1999, **Dr. Kathleen Weathers** (above) has been appointed IES Associate Scientist. Dr. Weathers has a long history with the Institute. Early in the 1980s she was a master's degree student at Yale University's School of Forestry and Environmental Studies, collecting cloud water for chemical analysis. In 1984, when this pilot program grew to become the first nationwide study of cloud water chemistry, newly-hired IES Director Dr. Gene Likens — one of the principal investigators on the Cloud Water Project — hired her to run it at the Institute. Subsequently, her doctoral research at Rutgers University dealt with deposition of airborne pollutants in the Catskill Mountains and she received her Ph.D. in 1993. She completed her studies while also fulfilling responsibilities as the Head of Laboratory Services at the Institute, a position she still holds. Dr. Weathers is a forest ecologist, and her research is largely biogeochemical; recent articles in the IES Newsletter have described her work on nitrate in Catskill Mountain streams (May-June 1996) and on cloud water chemistry and nitrogen deposition in Chile (January-February 1999). ●

Ecology Day Camps: 2000

Call the Education Office at 914-677-3459 for more information on the following:

Spring Ecology Day Camp April 17 - 20

Students in grades 4-6 explore the IES fields and forests, doing ecological investigations, hiking, and nature arts and crafts.

Registration deadline: March 31

Summer Ecology Day Camp
Eight sessions: June 26 - August 22
Students in grades 2-7 become IES ecologists-for-a-week and study a range of ecosystems on the 2000-acre Institute property. Through fun hands-on activities such as scientific experimentation and nature arts and crafts, they add to their knowledge of local ecosystems.

Registration deadline: June 2

Summer Ecology Day Camp
Junior Counselor Positions
Former IES campers entering grades 8-12 in fall 2000 may apply to become Junior Counselors at the IES Summer Ecology Day Camp. Junior Counselors are role models for campers and assist instructors with camp duties. Only eight are selected, one for each week-long session.

Application deadline: April 15

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the Hudson River's macrophyte beds because of the zebra mussel invasion and because of the maps that Dr. Findlay has compiled. *Valisneria* and *Trapa* are playing an increasingly important role in the Hudson River ecosystem, and IES ecologists are now collecting the scientific data that will more fully describe this role.

Institute of Ecosystem Studies scientists and students, with colleagues at other institutions, have been doing research on the Hudson River ecosystem since 1986. The scope of the work is broad, encompassing biogeochemistry, food webs, invertebrates, tidal wetlands and fish. The group focuses on the tidal-freshwater portion of the river, a 200-km stretch of the Hudson River Estuary from Troy south to the Tappan Zee Bridge. To date, Institute ecologists have published some 70 peer-reviewed scientific papers detailing their discoveries about the river's ecosystem.

Mr. David Fischer, Ms. Susan Dye, Mr. Greg Lampman and Ms. Heather Malcom are the research assistants currently working with IES scientists on Hudson River studies. ●



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Calendar

CONTINUING EDUCATION

For **winter/spring 2000** program information, or to request a catalogue, call the Continuing Education office at 914-677-9643. Upcoming programs include:

Gardening

- Mar. 4: **Creating the Ornamental Vegetable Gdn.**
- Mar. 5: **Trees: Lndscpe. Uses, Selection & Planting**
- Mar. 6 (4 sessions): **Fundamentals of Gardening**
- Mar. 11: **Garden and Landscape Makeover Tips**
- Mar. 12: **Trees: Care and Maintenance**
- Mar. 18: **Water Gardens**
- Mar. 25: **Basic Cultural Techniques for Perennials**
- Apr. 1: **Container Gardening**
- Apr. 1: **Formality and Informality in Gardens**
- Apr. 6 (6): **Insect Pests and Diseases of Plants**
- Apr. 8 (4): **Plants for the Landscape: Woody Plants**
- Apr. 8: **Don't "Fight the Slight"**
- Apr. 15: **Water Lilies and Other Aquatic Plants**
- Apr. 30: **The Basics of Stone Wall Construction**

Landscape Design

- Mar. 7 (8): **Landscape Design III**
- Mar. 19: **Inspired Residential Landscape Design**
- Mar. 25: **Contour Plans**

Natural Science Illustration

- Mar. 15-17: **Pen and Ink I: Techniques**
- Mar. 15-17: **An Introduction to Colored Pencil**
- Mar. 18 &/or 19: **Colored Pencil Drawing/Grnhse.**
- Apr. 13 (5): **Selected Concepts from "Drawing on the Right Side of the Brain"**

Biology and Earth Science

- Mar. 2 (8): **Plant Anatomy and Physiology**

Workshop

- Mar. 1: **Selling a House by the Yard**
 - Apr. 29 (4): **Seed to Harvest: Growing Vegetables at a Small Organic Farm**
- Ecological Excursions and Garden Tours*
- Mar. 13: **New England Flower Show**
 - Apr. 26: **Brandywine Valley Spring Garden Tour**

Natural Science Book Club

The IES Continuing Education Program sponsors a book club that explores titles in the fields of gardening, natural history, landscape design and environmental science. Open to the public, the gatherings bring together those with dual interests in nature and reading. Free. Call (914) 677-9643 for information.

IES SEMINARS

Free **scientific seminars** are held each Friday from September until May at 11:00 a.m. in the IES Auditorium on Route 44A.

- Feb. 25: **Links Between Species Introductions and Dissolved Oxygen Declines in the Hudson River Estuary.** Dr. Nina Caraco, Inst. of Ecosystem Studies
- March 3: **Botanical Exploration of Central French Guiana: The First Step Toward Understanding Biocomplexity.** Dr. Scott A. Mori, The New York Botanical Garden
- March 10: **Factors Controlling Nutrient Discharges from Watersheds.** Dr. Thomas E. Jordan, Smithsonian Environmental Research Center
- March 17: **Cities of Light: Are They Changing the Rhythms of the Night?** Dr. Marianne V. Moore, Wellesley College
- March 31: **Toward an Ecological Understanding of Fire in Eastern Kentucky.** Dr. Mary Arthur, University of Kentucky
- April 7: **Nitrogen Cycling in Wet Tropical Forests: An Exercise in Thinking Backwards.** Dr. Whendee Silver, University of California-Berkeley
- April 14: **Ecosystem Engineering in a Temperate Oak Forest: The Role of Leaf-tying Caterpillars.** Dr. John T. Lill, University of Missouri-St. Louis
- April 28: **Regional Scale Analysis of Lyme Disease.** Dr. Thomas Caraco, SUNY-Albany
- May 5: **Dynamics of Texas Coastal Plain Forests: Inferences from Longitudinal Data.** Dr. Paul Harcombe, Rice University

THE ECOLOGY SHOP

New in the Shop ... as promised, more local crafts: cane weavings by Cathy Gorham ... soapworks ... **for children** ... lady bug and firefly T-shirts ... nature "fact pack" collector cards ... **and in the Plant Room** ... a new batch of houseplants ... *Burt's Bees'* lip balm, hand salve and poison ivy soap

Senior Citizens Days: 10% off on Wednesdays

- *Gift Certificates are available* •

GREENHOUSE

Visit the IES greenhouse, a year-round tropical plant paradise and a site for controlled environmental research. The greenhouse is open until 3:30 p.m. daily with a free permit (see HOURS).

HOURS

Winter hours: October 1 - March 30

Public attractions are open Mon. - Sat., 9 a.m.-4 p.m. & Sun. 1-4 p.m., with a free permit.

(Note: The Greenhouse closes at 3:30 p.m. daily.)

The **IES Ecology Shop** is open Mon.-Fri., 11 a.m.-4 p.m., Sat. 9 a.m.-4 p.m. & Sun. 1-4 p.m.

(The shop is closed weekdays from 1-1:30 p.m.)

• *Free permits are required for visitors and are available at the IES Ecology Shop or the Education Program office daily until 3 p.m.*

Summer hours begin April 1: The Ecology Shop will be open until 5 p.m., grounds until 6 p.m.

MEMBERSHIP

Join the Institute of Ecosystem Studies. Benefits include subscription to the newsletter, member's rate for courses and excursions, a 10% discount on IES Ecology Shop purchases, and participation in a reciprocal admissions program. Individual membership: \$30; family membership: \$40. Call Ms. Laura Corrado in the Membership Office at 914-677-5343.

The Institute's Aldo Leopold Society

In addition to receiving the benefits listed above, members of The Aldo Leopold Society are invited guests at spring and fall IES science updates. Call Ms. Jan Mittan at 677-5343.

TO CONTACT IES ...

... for research, graduate opportunities, library and administration:

Institute of Ecosystem Studies
Box AB

Millbrook NY 12545-0129

Tel: 914-677-5343 • Fax: 914-677-5976

Street address: Plant Science Building,
Route 44A, Millbrook, N.Y.

... for education, general information and the IES Ecology Shop:

Institute of Ecosystem Studies
Education Program, Box R
Millbrook NY 12545-0178

Tel: 914-677-5359 • Fax: 914-677-6455

IES Ecology Shop: 914-677-7649

Street address: Gifford House Visitor and Education
Center, Route 44A, Millbrook, N.Y.

... IES website: www.ecostudies.org

For information on current IES public events and attractions, visit: www.ecostudies.org/welcome/ThisWeek.html.

For garden tips, follow the link to the Perennial Garden Archives.